Short-range horizontal disruption by verbenone in attraction of mountain pine beetle (Coleoptera: Scolytidae) to pheromone-baited funnel traps in stands of lodgepole pine

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ABSTRACT

Verbenone interrupted the attraction of mountain pine beetle, *Dendroctonus ponderosae* Hopkins, to baited multiple-funnel traps at a distance of <4 m. Catches of beetles in traps placed ≥4 m from traps with verbenone were not significantly lower than catches in control traps. These results are consistent with the short-range phenomenon of "switching" exhibited by mountain pine beetle in the formation of a spot infestation in stands of lodgepole pine.

Key words: *Dendroctonus ponderosae*, Coleoptera, Scolytidae, verbenone, antiaggregation pheromone, multiple funnel trap

DISCUSSION

Non-destructive semiochemical-based tactics to control populations of the mountain pine beetle, *Dendroctonus ponderosae* Hopkins, are appealing where resource management objectives cannot tolerate removal of infested trees (Borden and Lindgren 1988). Verbenone is an antiaggregation pheromone used by *D. ponderosae*, to interrupt attraction of beetles to trees already colonized by beetles (Lindgren and Borden 1989). However, operational trials of verbenone to disrupt populations of mountain pine beetles have had mixed success in stands of lodgepole pine, *Pinus contorta* var. *latifolia* Engelmann, (Amman and Lindgren 1995). Verbenone has been ineffectual in stands of ponderosa pine, *P. ponderosae* Laws. (Bentz et al. 1989). Two methods of application have been used in these verbenone trials: (1) aerially-applied verbenone-impregnated polyethylene beads; or, the most common method, (2) bubblecaps containing verbenone and attached to trees in a grid system. The concentration of bubblecap devices deployed in most trials in British Columbia has been about 100/ha (10 by 10 m spacing regime) (Amman and Lindgren 1995). My objective was to assess the effective range of verbenone, released from bubblecaps, in interrupting the attraction of *D. ponderosae* to its aggregation semiochemicals over a range of 10 m.

On 17 August 1991, seventy 12-unit Lindgren multiple-funnel traps (Phero Tech Inc., Delta BC) were deployed in stands of mature lodgepole pine near Penticton, British Columbia, in ten sets of seven traps per set. The infestation levels of pines by *D. ponderosae* in these stands varied from 10-20% of live trees. One trap in each set was randomly positioned, serving as the first trap for the subsequent array of traps along a randomly selected compass direction. Five additional traps within each set were positioned in a linear array, starting 2 m from the first trap, with a space of about 2 m between traps. The seventh trap in each set was set 10 m from the last trap in the array (20 m from the first trap) and in the same line, to test if the effect of verbenone was similar across a distance of 10 m. Each trap was hung between trees with twine such that the bottom of each trap was about 0.5 m above ground. No trap was within 2 m of any tree. Sets of traps were spaced 1

– 5 km apart. All traps were baited with the primary aggregation semiochemicals for *D. ponderosae* (Skillen et al. 1997): (±)-*exo*-brevicomin flex lure (chemical purity >98%); polyethylene bubblecap lure containing a 13:87 mixture of *cis*-and *trans*-verbenol [chemical purities 98%, enantiomeric composition 83:17 (–):(+)]; and polyethylene bottle containing myrcene (chemical purity >95%). In five randomly selected sets of traps (designated as treated), the first trap in the array was baited additionally with a verbenone bubblecap (black polyethylene bubblecap containing verbenone [chemical purity >98%, enantiomeric composition 83:17 (–):(+)]). All lures were supplied by Phero Tech Inc. (Delta, British Columbia). The remaining five sets of traps were designated as controls. The verbenols were released at a combined rate of about 1.74 mg/d at 24 °C whereas verbenone and myrcene were released at about 14 and 281 mg/d at 24-28 °C, respectively (determined by weight loss) (PheroTech Inc. unpublished data). *exo*-Brevicomin was released at about 0.01 mg/d at 24 °C (determined by collection of volatiles) (PheroTech Inc. unpublished). Catches of insects were collected on 7 September 1991, terminating the experiment. Voucher specimens were deposited at the Entomology Museum, Pacific Forestry Centre (Victoria, British Columbia). The data were analyzed with the SYSTAT statistical package version 9.0 (SPSS 1998). Trap catch data [transformed by $\ln(y + 1)$] for control and treatment were subjected separately to one-way analysis of variance (ANOVA) using position of trap as the model factor. Fisher's least significant difference (LSD) multiple range test was performed when $P \leq 0.05$. Paired *t*-tests were used to compare mean catches in control and treatment traps for traps >4 m from the first trap.

Table 1.

Total catches of *Dendroctonus ponderosae* in baited Lindgren multiple-funnel traps from 20 August to 7 September 1991 near Princeton, British Columbia.

	Mean (±SE) number of beetles [a]	
Distance of trap from 1st trap (m)	Control ($n = 5$)	Verbenone treatment ($n = 5$)
0	92 ± 19.9 a	9 ± 2.9 a
2	86 ± 13.3 a	46 ± 15.6 b
4	78 ± 19.3 a	70 ± 20.4 bc
6	86 ± 17.6 a	56 ± 10.7 bc
8	86 ± 22.4 a	97 ± 20.8 c
10	59 ± 16.3 a	81 ± 19.0 bc
20	98 ± 21.2 a	70 ± 19.7 bc

[a] Means within the same column followed by the same letter are not significantly different at $P < 0.05$ (LSD test).

The effective range of verbenone in this study seemed to be less than 4 m from the release point (Table 1). There was a significant difference among mean trap catches of *D. ponderosae* in the treated set of funnel traps ($F_{6,28} = 6.733$, $P < 0.001$), with catches of beetles significantly lower in traps baited with verbenone than in any of the other traps in the treated set. There was no significant difference among mean trap catches of *D. ponderosae* in the control set of funnel traps ($F_{6,28} = 0.634$, $P = 0.702$) with a mean (±SE) catch of 84 ± 7 beetles per trap. The mean (±SE) total catch of *D. ponderosae* in traps ≥4 m in the control set (403 ± 83 beetles/set) was not significantly different from the mean total catch of beetles in traps ≥4 m from the verbenone-baited trap in the treated set (374 ± 69 beetles per set) (*t* test, df = 8, $P = 0.795$). Results from this study suggest that using the existing type of bubblecap device to disrupt aggregations of *D. ponderosae* in stands of lodgepole pine would require deployment of devices at a much higher density, and

subsequently would require an excessively high number of bubblecaps (>600-700 devices per ha at a spacing of 2–4 m). Further tests of verbenone to disrupt attacks by *D. ponderosae* should consider devices releasing verbenone at rates much higher than that of the black verbenone bubblecap used in past trials (about 14 mg/d at 24-28 °C).

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REFERENCES

Amman and Lindgren. 1995. Semiochemicals for management of mountain pine beetle: Status of research and application. pp. 14-22. In S.M. Salom and K.R. Hobson (eds.). Application of semiochemicals for management of bark beetle infestations — Proceedings of an informal conference. U. S. Department of Agriculture Forest Service General Technical Report INT-GTR-318.

Bentz, B., C. K. Lister, J. M. Schmid, S. A. Mata, L. A. Rasmussen and D. Haneman. Does verbenone reduce mountain pine beetle attacks in susceptible stands of ponderosa pine? U. S. Department of Agriculture Forest Service Research Note RM-495.

Borden J.H. and B.S. Lindgren. 1988. The role of semiochemicals in IPM of the mountain pine beetle. pp. 247-255. In T.L. Payne and H. Saarenmaa (eds.). Integrated control of scolytid bark beetles. Virginia Polytechnic Institute and State University, Blacksburg VA.

Lindgren, B. S. and J. H. Borden. 1989. Semiochemicals of the mountain pine beetle (*Dendroctonus ponderosae* Hopkins). pp. 83-88. In G.D. Amman (compiler). Proceedings – Symposium on the management of lodgepole pine to minimize losses to the mountain pine beetle. U.S. Department of Agriculture Forest Service General Technical Report INT-262.

Skillen, E. L., C. W. Berisford, M. A. Camann and R. C. Reardon. 1997. Semiochemicals of forest and shade tree insects in North America and management applications. U.S. Department of Agriculture Forest Service Publication FHTET-96-15.

SPSS Inc. 1998. SYSTAT 9.01 Statistics. Chicago, IL.